

What is claimed is:

- 1 1. A method comprising the steps of:
 - 2 (a) forming a doped layer over a substrate, the doped layer comprising
3 (1) an organo-silicon compound and (2) either a first polymeric material or a first
4 precursor composition that can be converted to a polymeric material after the doped layer
5 has been applied, the doped layer having an outer surface and an inner surface, the inner
6 surface facing the substrate;
 - 7 (b) heating the doped layer and forming an organo-silicon-rich layer
8 on the outer surface of the doped layer;
 - 9 (c) converting the organo-silicon-rich layer to a silicon oxide-
10 containing layer; and
 - 11 (d) forming an added layer over the silicon oxide-containing layer, the
12 added layer comprising either a second polymeric material or a second precursor
13 composition that can be converted to a polymeric material after the added layer has been
14 applied to the silicon oxide-containing layer.
- 1 2. The method of claim 1 in which the first polymeric material is a
2 polyimide, a polyolefin, a polyepoxide, a polyurethane, or a polycarbonate.
- 1 3. The method of claim 1 additionally comprising the step of
2 applying a layer of adhesion promoter to the substrate before step (a) and in which the
3 doped layer is formed over the layer of adhesion promoter.
- 1 4. The method of claim 1 in which doped layer comprises a
2 polyimide precursor composition.
- 1 5. The method of claim 1 in which the added layer comprises a
2 polyimide precursor composition and the method additionally comprises, after step (d),
3 the step of heating the added layer to form a polyimide-containing layer.

1 6. The method of claim 5 in which doped layer comprises a
2 polyimide precursor composition.

1 7. The method of claim 6 in which the organo-silicon compound is
2 polydimethyl siloxane.

1 8. The method of claim 7 additionally comprising, after step (c) and
2 before step (d), the step of applying a layer of adhesion promoter over the silicon oxide-
3 containing layer.

1 9. The method of claim 8 in which the adhesion promoter is selected
2 from the group consisting of 3-amino-propyl-tri-ethoxy-silane, 3-glycidoxy-propyl-tri-
3 methox-ysilane, N-(2-amino-ethyl)-3-amino-propyl-tri-ethoxy-silane, 3-amino-propyl-tri-
4 methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-methoxy-silane, 3-isocyanato-
5 propyl-tri-ethoxy-silane, 10-amino-decyl-tri-methoxy-silane, 11-amino-undecyl-tri-
6 methoxy-silane, n-propyl-tri-methoxy-silane, and phenyl-tri-methoxy-silane.

1 10. The method of claim 1 in which the organo-silicon compound is
2 polydimethyl siloxane.

1 11. The method of claim 1 in which the substrate is an integrated
2 circuit device and the doped layer comprises a polyimide precursor composition.

1 12. The method of claim 11 in which:

2 the second precursor composition is a liquid that comprises an epoxy
3 compound, a hardener, and particles of a thermally conductive and electrically insulating
4 material; and

5 the method additionally comprises, after step (d), the step of heating the
6 added layer to form a polyepoxide.

1 13. The method of claim 12 in which the organo-silicon compound is
2 polydimethyl siloxane.

1 14. The method of claim 1 additionally comprising, after step (c) and
2 before step (d), the step of applying a layer of adhesion promoter over the silicon oxide-
3 containing layer.

1 15. The method of claim 14 in which the adhesion promoter is selected
2 from the group consisting of 3-amino-propyl-tri-ethoxy-silane, 3-glycidooxy-propyl-tri-
3 methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-ethoxy-silane, 3-amino-propyl-tri-
4 methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-methoxy-silane, 3-isocyanato-
5 propyl-tri-ethoxy-silane, 10-amino-decyl-tri-methoxy-silane, 11-amino-undecyl-tri-
6 methoxy-silane, n-propyl-tri-methoxy-silane, and phenyl-tri-methoxy-silane.

1 16. The method of claim 15 in which the added layer comprises a
2 polyimide precursor composition and the method additionally comprises, after step (d),
3 the step of heating the added layer to form a polyimide-containing layer.

1 17. A composite structure comprising, in order:

2 a substrate;

3 a polymeric layer including a first polymeric material selected from the
4 group consisting of polyimides, polyolefins, polyepoxides, polyurethanes, and
5 polycarbonates;

6 a silicon-oxide containing layer; and

7 an added layer including a second polymeric material selected from the group
8 consisting of polyimides, polyolefins, polyepoxides, polyurethanes, and polycarbonates.

1 18. The structure of claim 17 in which the first polymeric material is a
2 polyimide.

1 19. The structure of claim 18 in which the second polymeric material
2 is a polyimide.

1 20. The structure of claim 19 in which the substrate is an integrated
2 circuit device and the second polymeric material is a polyepoxide.

1 21. The structure of claim 20 additionally comprising a chip carrier
2 adjacent to the added layer.

1 22. The structure of claim 17 additionally comprising a layer of
2 adhesion promoter between the silicon-oxide containing layer and the added layer.

1 23. The structure of claim 22 in which the adhesion promoter is
2 selected from the group consisting of 3-amino-propyl-tri-ethoxy-silane, 3-glycidoxy-
3 propyl-tri-methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-ethoxy-silane, 3-amino-
4 propyl-tri-methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-methoxy-silane, 3-
5 isocyanato-propyl-tri-ethoxy-silane, 10-amino-decyl-tri-methoxy-silane, 11-amino-
6 undecyl-tri-methoxy-silane, n-propyl-tri-methoxy-silane, and phenyl-tri-methoxy-silane.

1 24. The structure of claim 23 in which the first polymeric material is a
2 polyimide.

1 25. A structure formed by the steps of:

2 (a) forming a doped layer over a substrate, the doped layer comprising
3 (1) an organo-silicon compound and (2) either a first polymeric material or a first
4 precursor composition that can be converted to a polymeric material after the doped layer
5 has been applied, the doped layer having an outer surface and an inner surface, the inner
6 surface facing the substrate;

7 (b) heating the doped layer and forming an organo-silicon-rich layer
8 on the outer surface of the doped layer;

9 (c) converting the organo-silicon-rich layer to a silicon oxide-
10 containing layer; and

11 (d) forming an added layer over the silicon oxide-containing layer, the
12 added layer comprising either a second polymeric material or a second precursor
13 composition that can be converted to a polymeric material after the added layer has been
14 applied to the silicon oxide-containing layer.

1 26. The structure of claim 25 in which the added layer comprises a
2 polyimide precursor composition and the method additionally comprises, after step (d),
3 the step of heating the added layer to form a polyimide-containing layer.

1 27. The structure of claim 25 in which the substrate is an integrated
2 circuit device and the doped layer comprises a polyimide precursor composition.

1 28. The structure of claim 27 in which the second precursor
2 composition is a liquid that comprises an epoxy compound, a hardener, and particles of a
3 thermally conductive and electrically insulating material, and the method additionally
4 comprises, after step (d), the step of heating the added layer to form a polyepoxide.

1 29. The structure of claim 25 in which the method additionally
2 comprises, after step (c) and before step (d), the step of applying a layer of adhesion
3 promoter over the silicon oxide-containing layer.

1 30. The structure of claim 29 in which the adhesion promoter is
2 selected from the group consisting of 3-amino-propyl-tri-ethoxy-silane, 3-glycidioxy-
3 propyl-tri-methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-ethoxy-silane, 3-amino-
4 propyl-tri-methoxy-silane, N-(2-amino-ethyl)-3-amino-propyl-tri-methoxy-silane, 3-
5 isocyanato-propyl-tri-ethoxy-silane, 10-amino-decyl-tri-methoxy-silane, 11-amino-
6 undecyl-tri-methoxy-silane, n-propyl-tri-methoxy-silane, and phenyl-tri-methoxy-silane.

1 31. A method for reducing the interaction of naturally occurring
2 radiation with an integrated circuit device comprising the steps of:

3 (a) provided an integrated circuit substrate;

4 (b) forming a doped layer over the substrate, the doped layer
5 comprising (1) an organo-silicon compound and (2) either a first polymeric material or a
6 first precursor composition that can be converted to a polymeric material after the doped
7 layer has been applied, the doped layer having an outer surface and an inner surface, the
8 inner surface facing the substrate;

9 (c) heating the doped layer and forming an organo-silicon-rich layer
10 on the outer surface of the doped layer;

11 (d) converting the organo-silicon-rich layer to a silicon oxide-
12 containing layer; and

13 (e) forming an added layer over the silicon oxide-containing layer, the
14 added layer comprising either a second polymeric material or a second precursor
15 composition that can be converted to a polymeric material after the added layer has been
16 applied to the silicon oxide-containing layer.

1 32. The method of claim 31 in which the naturally occurring radiation
2 comprises alpha particles.